ON THE

VOLUNTARY AND INSTINCTIVE ACTIONS

OF

LIVING BEINGS.

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(*From the Edinburgh Med. and Surg. Journal, No.* 132.)

The inquiry on which I am about to enter derives a peculiar degree of interest from the extent of the field embraced by it, and the importance of its character; whilst the complicated nature of the relations subsisting between its objects renders it one of no ordinary difficulty. This difficulty has, I think, been much increased, by the erroneous method in which the investigation has usually been prosecuted, as well as by the number of exploded theories, whose shades still hover in the darkness that envelopes the subject; and these have been productive of injurious effects, by the doubt which they have often cast over established facts, and by the number of fallacious statements which they have almost inseparably mixed with truth. I am far from supposing that it is in my power to shed new light upon the questions I am about to discuss. I have little claim to novelty in any of the views I shall bring forward, since they have almost all been propounded by different authors, of more or less reputation in their respective departments; and the object I have chiefly in view is to show in what manner they may be harmonized and connected, so as to form one uniform system.

Before entering upon the investigation, however, it may be advantageous to make a few remarks on the comparative value of observation and experiment, in the elucidation of the causes of the phenomena exhibited by living beings. By *observation*, we take cognizance of the sequences of these phenomena as presented to us by nature; but their complication too often renders it impossible to analyse them with such clearness as to be able to attribute each effect to its peculiar cause. Hence the *experimental* inquirer endeavours to arrange his causes into new combinations, in such a manner, as to produce a different set of results by the comparison of which, the *vera causa* of each ef-

* The substance of the following paper was read as a communication to the Royal Medical Society, March 23, 1837.

fect may be arrived at by the method of exclusion. And it will be remarked, that observation is here necessary to take advantage of the new set of phenomena presented by experiments; and the inductive processes founded upon each are precisely similar. But there are obvious limits to the employment of experiment in the investigation of the laws of vitality. The physiologist has by no means the same power of selecting and arranging his causes, for the purpose of observing their results, as that which is possessed by the chemist or the mechanician. If he take away an essential part of a living structure, it no longer exhibits even a trace of those properties of which it is his object to ascertain the laws; and, on the other hand, he fails in all his attempts to produce any of the phenomena of vitality by new combinations of inorganic elements. Here, however, a judicious and careful system of observation will almost supply the place of experiment; for the ever-varying forms of organized beings by which we are surrounded, and the constantly changing conditions in which they exist, present us with such numerous and different combinations of causes and effects, that it must be the fault of our mode of study, if we do not arrive at some tolerably definite conclusions as to their mutual relations. In our investigation of the laws of vital phenomena, therefore, we may advantageously commence with the observation of those instances in which the results are presented to us in the simplest form; and if we can thus attain a knowledge of their *veræ causæ*, it will be of great assistance to us in the analysis of the more intricate combinations to which we afterwards proceed. Let me not be understood, however, as wishing in the slightest degree to underrate the value of experiment; but merely to show in what manner its place may in some measure be supplied, when difficulties stand in the way of its employment.

One of the chief difficulties which arises at the outset of our present inquiry, originates from the self-esteem inherent in man, which has led him to arrogate to himself the sole prerogative of reason; and to maintain that the springs of action which prompt the movements of the lower animals are of a character essentially different from those which regulate his own. Hence has sprung the absurdity of the application of the term instinct to the psychical endowments of every being under the sway of the "lords of creation," and the difficulties which have consequently been raised in the analysis of their actions. This doctrine is, however, rapidly giving way before a more extended spirit of philosophy; and few who have fully investigated the subject are now indisposed to allow that many of the lower animals are endowed with the power of carrying on processes of reasoning, as complete as those performed by man, though of a less complicated character. It is not my intention to enter into

an elaborate discussion of this question at the present time; but considering it as decided, I shall rather seek to distinguish the purely instinctive actions, from those which are the result of mental processes, and to determine the parts of the organism, on which they are respectively dependent.

In this examination, I shall therefore follow the principles which I have just laid down, by commencing with the simplest class of the instinctive actions performed by living beings. Although many writers have objected to the application of the term *instinct* to the vegetable kingdom, it has been, I apprehend, principally because the ideas of sensation, consciousness, and volition have been more or less mixed with their notion of its import. But, as I shall presently show, though these conditions frequently accompany instinctive actions, and sometimes partake in their production, they cannot be truly regarded as essential to them.

The first action of a living being is the absorption and assimilation of its aliment. No one will deny that this is the result of the adaptation of its organism to surrounding circumstances. But there are in the mode in which this process is performed in plants, some peculiarities which claim our attention. What power of *selection* do the roots possess, and how is it regulated? From the little that is known on this subject, I think that it may be inferred that the rejection of any particular ingredient of the fluid in contact with the roots, results either from the want of adaptation in the form or size of its molecules to the pores of the spongioles, or to an organic change effected by it on their delicate tissue. Again, it has often been asked—why do the roots of plants always direct themselves towards a damp soil? This fact has frequently been adduced in proof of the sensibility enjoyed by vegetable organism; but few now regard it in any other light than as an illustration of the exquisite design manifested in the laws of the vegetable economy. It is an established fact that the root only increases in length by additions to its point, (except in a few instances of no importance to the present inquiry;) and that the addition is made in the direction of least resistance, which will always be that where the soil has been rendered yielding by the percolation of fluid. Another fact relating to the growth of the roots has been less frequently noticed. "When two roots of the same kind are planted, the one in a sheltered, and the other in an exposed situation, the former pushes forth its roots in all directions, more especially where there is the greatest supply of nourishment and the highest temperature; while the latter, which, were it to act in the same manner, would be speedily overturned; multiplies its roots in the direction of the strongest blasts, and these acting like the stays of a ship's mast, preserve the trunk in its

vertical position." * The author from whom I have quoted this fact does not attempt to explain it; but I think that it may readily be accounted for in the following manner. Mr Knight has shown that the motion of the trunks of trees by the wind is of material assistance in the downward propulsion of the sap; for having confined a stem in such a manner that it could only vibrate in one plane, he found that its increase in diameter in that direction was considerably greater than in the transverse line. It is evident, that the same cause will influence the growth of the roots given off from the longest diameter of the stem; and that a tree which is violently acted on by blasts of wind which strike it most frequently from one quarter, will of necessity send out the strongest and longest roots in the same direction. The tendency of plants to grow towards the light may be explained upon similar principles. The illuminated side of the stem becomes hardened and contracted by the fixation of carbon and the exhalation of moisture; whilst the darkened side continuing to grow more luxuriantly, incurvation of the axis takes place. In all these cases of instinctive action, therefore, the effect is manifestly produced by the immediate agency of external stimuli upon an organization fitted to respond to it.

It would occupy too much time to attempt at present to demonstrate the close connection which every process of vegetable growth has with the nature and degree of the stimuli which excite it; and I must content myself with adverting to one or two of the most remarkable of the evident motions exhibited by plants. We can have no hesitation in allowing to certain tissues, in particular vegetables, a power of contractility evinced by the effect of a stimulus applied to the part itself, scarcely inferior to that which characterizes the muscular fibre of animals. Thus the leaves of the lettuce force out their milky juice upon the slightest touch; and the contraction of the vesicles on one side of the filament of the barberry, when irritated by the point of a pin, causes its immediate curvature. Many similar instances might be enumerated; but there are other vegetable motions still more remarkable, where a stimulus applied to one organ produces an effect upon a distant part. Of this character are the closing of the trap of the *Dionæa*, and the folding of the leaves and drooping of the petiole of the sensitive plant. The latter phenomenon has been well explained by Dutrochet and Mayo; the contraction of the part irritated forces a portion of the fluid contained in its vesicles along the vessels of the petiole; and thus being propelled into the intumescence at the junction of the latter with the stem, distends the *upper* side of it, and thus produces flexion of the leaf-stalk. A similar effect is produced

* Fleming's Philosophy of Zoology, Vol. i. p. 118.

by irritating the lower part of the intumescence, or by cutting a notch in it; the contraction of its tissues enables the elasticity of the upper portion (which in its perfect state it counterbalances) to produce a similar depression of the petiole. The impression is here propagated from the part irritated to a distant organ, but not by means of an instantaneous influence transmitted by a nervous system. The vital property of contractility called into play by its appropriate stimulus, gives rise to a series of strictly mechanical actions; and by the peculiar adaptation of the structure of the plant to these, motion of distant parts is excited.

Some interesting facts connected with the action of poisons on plants lead to the same general result. The effects of metallic irritant poisons appear to be propagated solely through the circulating system. Thus arsenic introduced into the ascending current of sap will destroy the vitality of the line of the trunk and branches, along which that portion of the current passes, without immediately injuring the remainder of the tree. In one of Marcet's experiments, a quantity of arsenic introduced into one of the branches of a lilac, was six weeks in producing the death of the entire plant; and it was remarked by Drs Christison and Turner, in their experiments on the effects of poisonous gases, that those which rank as irritants in relation to animals, appear to act locally on vegetables without any of that sympathetic influence on general life, which is one of their most remarkable effects in the other kingdom. The action of narcotic poisons is somewhat less easy of explanation. They seem at once to destroy the excitability of the parts to which they are applied, and their action is more universal than that of the former class; but I do not myself see any necessity for referring the transmission of their effects through the plant to the operation of a nervous system.

I have dwelt at some length on the phenomena exhibited by vegetables, because I apprehend that the proper explanation of them will assist us in our researches into the instinctive actions of animals. All the actions manifested by plants, may I conceive, be regarded as the direct, and, in many instances, the obvious result of the *respondence of their organism to stimuli fitted to excite it;* and whenever any of these stimuli produces an action in a distant organ, its effect appears to be propagated solely by the circulation of fluid.

My next object will be to prove, that the purely instinctive actions of animals may be comprehended in the same general definition; but that they differ from those of plants in this important respect, that they are not merely connected with the system of organic life, but also with that appropriated to the discharge of the exclusively animal functions, namely, the nervous

and muscular apparatus. From the nervous system being more or less involved in their performance, they are put in some respects on a new footing; but I hope to show that no strictly mental processes are necessary to their manifestation; and that this system acts only by its respondence to stimuli expressly adapted to itself, and by the immediate transmission of the excitation produced by these stimuli to distant parts of the organism.

Before entering, however, upon the consideration of the animal kingdom, let us pause for a moment at the threshold to inquire what are to be regarded as its essential characteristics. The naturalist seeks to establish his classification upon external signs easy to be recognized and comprehended; hence he has recourse to the possession or absence of an internal digestive cavity, the nature of the food, the effects produced by respiration, &c. as his chief diagnostics; but none of these can be alone relied on, and a distinction founded upon them is at best but a superficial one. The physiologist, on the other hand, endeavours to separate the animal from the vegetable kingdom by its possession of the powers of sensation and volition, manifested by the act of voluntary motion; and this is certainly to be regarded as the essential character of an animal, since a being enjoying it would still belong to that division of the organized world, whatever might be its structure; and, on the other hand, a being formed in all respects like an animal, with the exception of its nervous system, (were it possible for such a being to exist) and the consequent deficiency of the powers which it confers, must unhesitatingly be placed in the vegetable kingdom.* Every one must be aware, however, of the difficulty of carrying any such test into practical application; since among many of the lowest tribes of organized beings we observe motions which can scarcely be referred with certainty either to the accidental influence of external causes, or to a stimulus originating in the individual. It appears to me, however, that there has been too much anxiety to draw a definite boundary line; and that without having recourse to the third or intermediate kingdom, proposed by some continental naturalists, we may consider the transition from one division to the other to be of the same gradual character, as is apparent between all great natural groups, when none of the connecting links have ceased to exist. It has, I think, been too much the custom to attribute the motions of the lowest animals to the same spontaneous powers of whose existence in the highest classes we can have no doubt; without sufficiently attending to the fact, that in the former, there is no trace of the presence of those parts of the nervous system which in the latter

* I do not of course allude to *monstrous* productions.

correspond (to say the least) with their manifestation. I shall endeavour, therefore, to trace the successive complication of the chain of causes and effects in the actions performed by animals, reasoning rather from below upwards, than from above downwards; since it appears to me that animals of the inferior orders (especially those now included in the division Acrita) bear much more resemblance to vegetables in the *totality* of their vital actions, than to the higher members of their own kingdom.

It is necessary that, before proceeding farther, I should specify the sense in which I am about to employ certain terms to which different authors have attached a great variety of meanings. These terms relate to the process by which the thinking mind takes cognizance of the qualities of external objects; a process which, though apparently simple, is resolvable into many steps, each of which has its appropriate designation. In the first place, an *impression* is produced upon the organ of sense by its appropriate stimulus, and this impression is propagated along the nerve which connects it with the *sensorium commune*. We are justified in regarding the formation and propagation of this impression as a strictly corporeal function, although we cannot trace the organic change of the nervous system by which it is accompanied. * This impression conveyed to the sensorium gives rise to that mental change which is termed *sensation*, which may be regarded as the passive reception by the mind of the impression made upon the organ of sense, which thus communicates to it the simple notion of the presence of an external object. For this change to take place, let it be observed, consciousness is all that is requisite; and if consciousness exist, and the nervous communication be perfect, sensation must follow an impression. The mental change termed perception may or may not follow according as the attention is directed to the sensation; and this change consists in the formation of a notion of the qualities of the external object, derived by inference from the sensation. The first stage of the process is therefore purely corporeal; the third purely mental; the second is the stage of transition by which the body communicates with the mind.

Now for each of these steps in the action of the body on the mind, I think that a corresponding step may be traced in the reciprocal action of the mind upon the body. Before a perception can occasion any corporeal change, it must have given rise to various mental processes, such as association, judgment, &c. with the nature of which we have at present nothing to do. These, however, all terminate in the formation of a *volition*, which may I think be regarded as a strictly mental act,† and as holding a

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* Prichard on the Vital Principle, p. 147.
† Roget's Physiology, Vol. ii. p. 535, note.

corresponding rank with perception in the scale I am attempting to describe. This mental act gives rise to a physical change in the sensorium, to which I do not find that metaphysicians have given a name; a change which corresponds in an opposite direction with that of sensation, and which for convenience I shall at present denominate the *motive action*.* This motive action propagated along its appropriate nerve, stimulates the muscular fibre, and thus produces voluntary motion; and this stage of the process, which for want of a better term I may denominate *stimulation*, † is evidently reciprocal to the impression at the commencement of the nervous cord. We may then arrange these processes in the following table, which will shew their mutual relation.

Impression		Stimulation.
↕		↕
Sensation		Motive action.
↕		↕
Perception ——— ▷	Mental acts	——— ▷ Volition.

I have thus endeavoured to analyze the steps of the process by which voluntary motions result from impressions on the organs of sense. We have now to examine whether there can be no more direct connection between an impression and a motion. The whole class of what are usually regarded as automatic or strictly involuntary motions will at once occur to us. Adopting the doctrines of Haller on the irritability of muscular fibre, we perceive that the contraction of the purely involuntary muscles, such as the heart, and the muscular coat of the alimentary canal, results from a stimulus applied directly to themselves, without the intervention of nervous agency. I scarcely perceive how we can distinguish this contraction from that which occurs in the irritable tissues of plants, and the structure, by which it is performed, gradually loses its peculiar character as we descend in the animal scale, until we can perceive no trace of it whatever. These contractions may then be regarded, like those of vegetables, as forming part of the *organic* functions of the being, since they are entirely independent of nervous influence; and as forming, together with the changes (probably of a strictly physical character, although called into play by vital action,) which constitute the functions of absorption, assimilation, &c. the

* The term motive action I employ as corresponding with the "influence of volition" of some writers. If volition be a purely mental act, and an organic change take place in the nervous system as its consequence, it is evidently desirable not to confound these processes, as has been done by those writers who speak of *motion* as the direct result of volition. I am no advocate for the multiplication of terms, and shall feel happy to dispense with these, if it can be shown that they are unnecessary.

† I employ the term *stimulation* to designate this stage of the process, as implying the action of the nervous power upon the muscular fibre, which corresponds, according to the Hallerian doctrine of irritability, with that of other stimuli applied directly to the latter.

lowest class of instinctive actions in which we can trace most clearly and immediately the respondence of the organism to external stimuli.

Now it is probable that in the lowest animals which present any traces of a nervous system, it exists in that form which is such an interesting stage in the development of the higher organisms—namely, a number of nervous filaments radiating from the circumference, but unconnected with a common centre. In the sub-kingdom Acrita, no vestige of a nervous system can be detected; and it is generally supposed to be present in a *diffused* form; that is to be distributed in insulated globules through the tissues. Our ideas of the transmission of nervous influence forbid us from believing that, in the first of these cases, and much less in the second, there can be anything like a *sensorium commune;* and I am much mistaken if a rigid analysis of the motions of these animals would not enable us to refer most of them to the immediate action of external stimuli, and thus to the same class of instinctive actions as the motions of plants and the contraction of the purely involuntary actions of animals. Let us take for example the common polype *(Hydra viridis;)* in its bodily structure we may regard it as *all stomach*, and every action it performs, is directed towards filling its digestive cavity, since its generative functions are altogether beyond its control. The irritable tentacula surrounding its mouth contract upon the slightest touch, and inclosing whatever may be in contact with them, endeavour to convey it to that aperture. Now we have here a remarkable analogy on the one hand, with the *Dionæa muscipula*, whose curious motions would seem to have a similar object; and, on the other, with the motions of the muscular part of the alimentary tube in higher animals, a correspondence, indeed, so strong between the *effects*, that it would be unphilosophical to suppose the *cause* to be different. With regard to the other motions exhibited by the same animal, I am inclined to believe that they may be mostly accounted for by the direct stimulus of light, heat, &c. like those of plants. I am far from wishing, however, to deny to the creature some degree of sensation exciting pleasure or pain, and of volition in directing its movements; but I conceive these to be very small, and to be but little effectual in the maintenance of its organic functions, which are supplied by this simplest kind of respondence of the organism to external stimuli, which I may call *organic instinct.*

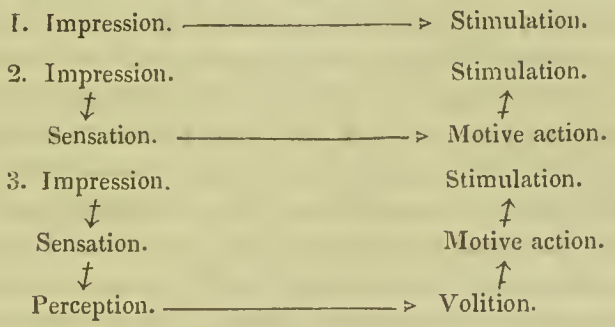
It is a principle of which every one must be aware, that in proportion as we rise in the animal scale, we find the action of external stimuli giving place to that of internal volition. Thus we all know that most animals are more susceptible than man of atmospheric changes; and that those individuals of the latter species are usually most cognizant of them, whose mental facul-

ties are the weakest, or least appropriately employed. It does not necessarily follow, however, that these changes do not produce sensations in him ; but, on the contrary, it is probable that from the attention of the mind being directed to other objects, no perception of them takes place. I think that we shall be able to trace in the different muscles of the human body a gradation similar to that which we observe in the animal scale, with regard to the effects of the two kinds of stimuli.

Having now disposed of the first or lowest class of instinctive actions of living beings, we next pass to those which are connected with the nervous and muscular systems, and are therefore peculiar to animals, involving the organs of the life of relation. I have already stated my belief that in some of these, the nervous system acts merely as a *conductor* of stimulus from one organ to another, without the necessary intervention of any mental change ; and this I imagine to be the principal office of those connected fibres which we see in some of the Echinodermata on which no ganglia exist. The nerves, then, taken in this simple view, serve to establish an instantaneous communication between distant organs of the body, and at the same time to collect and harmonise the impressions made on all, so that no part may act independently of another.

There has been much controversy amongst physiologists as to the classification of those muscles which, being called into play in the living body by the stimulus of nervous power alone, are more or less under the control of the will. My friend Dr John Reid has suggested to me that the difficulty may be overcome by regarding every muscle in the body which is supplied by motor nerves, as equally susceptible of stimulation from two different sources, namely, volition, and sensation without volition. Thus any one will involuntarily draw back his foot if the skin be pricked or pinched ; and the same motion will be performed by the body of a frog after the brain has been removed. The muscles of the leg are not, however, frequently called into play in this manner, being more commonly acted on by volition. In the diaphragm, on the other hand, the uniform alternation of contraction and relaxation is kept up by the constant stimulus of the " respiratory sense," or " besoin de respirer," originating in the lungs, whilst the will is much seldomer called upon to act, and, as long as the stimulus continues, cannot altogether control the muscle. Hence the difference between the actions of the diaphragm and those of the most purely voluntary muscle in the body, is not one of *kind*, but simply depends upon the respective proportions of the two stimulating powers. I shall presently have to extend the view which Dr Reid has suggested to me, by showing that the contraction of a muscle may re-

sult not only from the direct stimulus of a sensation, but even from that of a simple impression. The following tables will show what I think may be regarded as the three modes of communication between an organ of sense, and a muscular fibre excited to contraction by nervous influence.



The first class of movements evidently corresponds with the excito-motory actions of Dr Marshall Hall, the Sympathetic of Dr Whytt and other writers. The constant association of particular muscular movements with certain impressions on the organs of sense has long been known, and has been a fruitful topic of discussion amongst physiologists. It has been usual to ascribe them to the intervention of sensation between the impression and the contraction; but of this I see no further proof than that they are always accompanied in the normal state of the system with this change in the sensorium (consciousness of course being present,) and that it is therefore difficult to suppose that they can take place independently of it. I think that it might be replied, however, that if the purely involuntary muscles contract by an impression immediately produced upon them, there is no great difficulty in supposing that in another instance contraction may be produced by an impression made on a distant part, the nervous cords acting simply as its conductors. The question is not, however, to be decided by *a priori* argument; it is one of fact, and to facts we shall now recur.

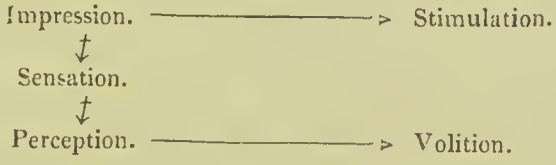
Whytt, Legallois, and many other physiologists have noticed the remarkable motions occurring in the extremities of animals after the brain has been removed, and have shown that the integrity of the circle of sensitive and motor nerves completed through the spinal marrow, is essential to their performance, since, when this circle is broken by the destruction of the spinal marrow, the motion ceases to follow the application of a stimulus. Hence, they concluded, that *sensation* remains in the spinal cord after the destruction of the brain; and Cuvier has sanctioned this view, by regarding them as a test of that process. But this assertion arises solely from the desire of preserving an apparent uniformity in the effects of impressions on the muscular system; and while laying great stress on the constancy of the accompany-

ing sensations while the brain is entire, they have overlooked the fact, that *perception* will follow as well as *sensation*, if the attention be awake and not directed to other objects. The same argument then which is used to invalidate their dependence upon perception, will also hold good against their being the result of sensation; for, except the continuance of these motions, we have no reason to believe that sensation can exist when the brain has been removed; and to say that sensation remains because these motions result from the application of stimuli; and that the motions follow the stimuli because sensation remains, is obviously arguing in a circle. It is impossible, therefore, to determine by experiments of this kind, whether the act of sensation can take place in the spinal cord or not; but inferences of a more certain kind may be drawn from pathological phenomena. Thus Mr Mayo relates a case * of palsy and complete loss of sensibility in one leg, in which nevertheless irritation of the toes produced retraction of the leg, without, as he was assured, any sensation on the part of the patient.

An interesting case, having a similar bearing, has been communicated to me by my friend Mr Madden, in whose words I shall relate it. "In the autumn of 1834, I was in attendance upon a case of complete paraplegia, in which it was necessary to employ the catheter twice daily. On several occasions, when the point of the instrument was passing the prostatic portion of the canal, where a slight obstruction existed, I observed that the patient jerked his legs violently; but upon inquiry he positively denied having experienced any sensation, being not even conscious of the presence of the instrument in the urethra. The disease appeared to have been originally induced by two severe injuries received a twelvemonth before. Upon dissection, the spinal cord in the lower part of the dorsal region was found completely disorganized, being converted into a semifluid pulp. The preparation has been placed in the Museum of the College of Surgeons." It may be objected that in this case the diseased state of the spinal cord forbids us from asserting that the motions were the direct result of the impression made in the urethra; but, it will be recollected, that such motions are not unfrequently perceptible in the healthy state of the nervous system, when any obstruction exists to the passage of an instrument; and that the phenomenon so frequently occurred in this instance as fully to point out the relation of cause and effect. I have no doubt that many cases similar to these will be detected, when the attention of practitioners is sufficiently called to the question.

* Outlines of Pathology, p. 154.

Again, Dr Ley * mentions a person in whom the *par vagum* appeared to be diseased; the lungs suffered in the usual way in consequence; and the patient had evidently laborious breathing, but said distinctly that he felt no uneasiness in the chest. Among the cases detailed by Sir C. Bell, at the end of his work on the Nervous System, there are several which have an interesting bearing on this question. Thus he mentions a case (151) in which there was no power whatever over any of the voluntary muscles, but those of the eyes and face; the tongue of the patient refused utterance, and her legs and arms lay motionless; yet she could swallow easily, and all the respiratory movements were performed. There are many other cases on record of the same kind; and in some of these it is related that muscles usually styled voluntary, but over which the will had no power, owing to the existence of paralysis, were excited by impressions connected with the respiratory organs. Now it is evident that there was in these cases no deficiency in the conducting and stimulating power of the nerves, nor in the mental act of volition; it must have been, therefore, in the process of motive action that the defect lay; and as sensation can only act through this channel, it is obvious that the impression derived from the respiratory organs must have produced direct stimulation, sensation accompanying the change, but not being essential to it. My meaning will perhaps be made more apparent by the following table.



In another instance (173) related by Sir C. Bell, the contrary state existed; the external respiratory muscles of the neck and chest would not obey the usual stimulus so as to dilate the chest for inspiration, although they were perfectly under the control of the will. Now if it is necessary that sensation be produced, and an act of volition excited, where is the seat of deficiency of power? Certainly not in the brain, for volition was strong; nor in the nerves of sensation, for these conveyed to the mind the sensation of distress; nor in the nerves of motion, for in the voluntary movements of the frame these muscles were put in action. The defect was evidently in the production of stimulation as a direct consequence of impression.

Without entering further into this question, I think that we are warranted in coming to this conclusion, which I state in the

* Essay on Laryngismus Stridulus, p. 417.

words of a late most able review on the subject. "As it is only by exciting a peculiar unknown change in the spinal cord that impressions on any sensitive nerves excite sensations in the mind, so it is quite possible that these changes in the spinal cord may not be wholly prevented from taking place in cases where disease of the brain or injury of the cord itself so far affects the spinal cord as to prevent sensations from being felt; *and that these changes, not the sensations which in the natural state accompany them, may be the causes of the sympathetic or involuntary motions.*" *

We may now briefly inquire what class of motions result in the usual conditions of the body from the influence of impressions only. It is of course very difficult to specify these; but I think that there is evidence that all the motions *immediately* concerned in the supply of the organic functions are thus performed. And in many of the lower animals possessed of a nervous system, and a complicated digestive apparatus, but endowed with little power of locomotion, such as the greater part of the acephalous Mollusca, these appear to be almost the only kind of actions which the organism is called on to perform. In the higher animals, the most obvious of these motions are connected with the act of respiration, which some authors have most unaccountably referred to an exercise of volition; but there are others as complex, although usually more directly controlled by the will, as for instance those of deglutition, defecation, and urination, which have been performed by acephalous infants;† and those essential to copulation which have been performed by men and animals labouring under complete paraplegia, in some of which cases it is stated that ejaculation took place without sensation. If, as Sir C. Bell believes, a peculiar column in the spinal chord is requisite for associating the roots of the nerves concerned in respiration, why should not each of these complex associated actions have its peculiar tract also? Instinctive movements referable to this *excito-motory* class, may, I think, be excited by atmospheric influences, which need not produce a definite sensation; and to this head I should refer the commencement and conclusion of hybernation in animals, (that of plants being entirely referable to the organic instincts,) and the activity of insects in sultry weather, especially before a thunderstorm. It would, however, be very premature to state this

* British and Foreign Medical Review, Vol. iii. p. 38.

† It might be objected to this view of the actions of acephalous infants, (all of which, it may be remarked, are *immediately* directed to the supply of their physical wants,) that if unpossessed of *sensation*, they must be regarded as mere automata. It may, I think, be fairly replied, that whether the movements are produced by sensations or are the direct result of impressions, they are still purely automatic, unless we suppose that the spinal cord may be the seat of *volition* as well as of sensation.

opinion with confidence in the present limited state of our knowledge on these subjects.

The next class of muscular movements comprehends those which are the direct result of sensations acting immediately on the motor nerves without the intervention of volition; and this will, I believe, comprehend all the remaining purely instinctive motions of animals, which minister less directly to their organic functions. I still call these *instinctive* actions, because they are the direct respondence of the organism to external stimuli; and do not appear to me to be dependent on the will, although more or less under its control, and although consciousness is essential to their production. They still present the same certainty and uniformity as are observed in the previous cases; they are performed without education in the first instance, and are not improved by practice. It would appear that the impressions made upon the organs of special sense can act in no way more direct than this; and the reason is evident. It is by them that animals take cognizance of distant objects not in immediate contact with their bodies, and therefore not holding a direct relation with their organic instincts. Now we observe that in many of the lower animals, certain actions result immediately from *sensation*, which in man are only performed after *perception* has taken place, and a notion thus formed of the character of the external object, which is only acquired by education. Thus the sight of an infant or of a person who has newly acquired this sense is educated by the touch; whilst many animals manifest by their actions that no such mental process is necessary; their sensations being, as it were, converted into motions without farther intervention. Thus a duckling upon being hatched will at once run to the nearest water; and a fly-catcher, just out of its shell, will peck at an insect within its reach, and seldom miss its aim. Where a succession of complicated motions is required for a particular purpose, as for instance the construction of a habitation, I think it probable that there may be a general act of volition controlling the whole, though each individual action is the result of its appropriate stimulus. It is generally allowed that there is in the *mind* of the animal performing the actions constantly observed in its species, nothing like an adaptation of means to end, this adaptation being in the physical confirmation of the nervous system, which, to use a very rough but approximate simile, may be constructed like the barrel of an organ, to play any tune that is set upon it, when the impulse is given by the motion of the handle. *

* It has been well remarked by Mr Macleay, that "perfection among the Annu-

To the same head may be referred a great variety of instinctive actions in man, though these are more liable to be obscured by the exercise of volition. Thus, for example, the motions necessary to maintain the balance of the body, or to save it from immediate danger, cannot be regarded as voluntary, since they may be performed when the attention of the mind is directed to other objects, and when perception cannot therefore take place. I am disposed to believe that the associated movements which have been acquired by habit may in like manner be performed by nothing more than a general act of volition directing the organs of sense to the appropriate objects; but that each separate movement is the result of a distinct stimulus from without acting on the shorter chain which habitual excitement has thus formed, although an effort of volition was at first necessary for each. As an illustration of my meaning, I may advert to the example so often cited, of a person playing a complicated piece of music whilst the attention is fixed upon a distinct train of thought. There is one case which would even lead to the belief that habitual muscular movements may be excited by *impressions* only; I refer to that of the lady mentioned by Dr Percival, who was much addicted to snuff-taking, and in a fit of profound apoplexy, when no other movements could be excited, irritation of the nostrils with a feather produced contraction of the thumb and finger of the right hand. But it would be absurd to draw a conclusion so important from a single case of this kind. I could wish to have dwelt longer on this part of my subject, but I have already exceeded the usual limits of a communication, and, in summing up that portion which relates to instinctive actions with one or two additional remarks, I may use the language of one of the most philosophical writers on this subject. "In effect, is instinct any thing else than the manifestation without of that same wisdom which directs in the interior of our body all our vital functions."

If we trace the successive steps of the process of digestion, by which the aliment is prepared for the action of the absorbent system, a process which is more specialized throughout the animal kingdom than any other, we shall observe, that in the higher classes, each of the different combinations I have above described has its distinct office in the supply of the organic instinct, and that we may trace along the alimentary canal a series of actions at first purely voluntary, and becoming more and more instinctive as we pass along, corresponding exactly with

losa seems always tending to make the animal a complicated machine, guided solely by the instinct implanted in it by its Creator; whilst in the Vertebrata, perfection seems to tend to make the animal a free agent, and to render it independent of external circumstances."

those which we meet with in descending the animal scale. Thus there can be no question that, in the human being, the prehension of food, and the conveyance of it to the mouth, are strictly voluntary acts; and these are the result of mental processes of a still higher order, connected with the special sensations, and having a more remote bearing on the function to which they minister. In descending through the animal scale, we shall find that the exercise of volition for this purpose soon gives place to pure instinct. The mastication of the food may be regarded as partly an instinctive process, partly habitual; requiring, in the adult, sensation to excite it and the general control of volition; it may therefore, I think, be regarded as an example of the highest class of instinctive actions, which we may denominate *sensori-motor*. The act of swallowing, on the other hand, is the result of an impression rather than a sensation, and is therefore (as Dr M. Hall has shown) one of the lower class or *excito-motor* actions. If Brachet's experiments be correct, the motion of the parietes of the stomach is caused by an impression conducted and reflected by the *par vagum*. The remainder of the motions of the alimentary canal, if Haller's theory be admitted, belong to the class of organic instincts, being the result of a direct impression. I think that if we revert again to the animal scale, we shall perceive that the sensori-motor actions must be lost when there is no longer a central sensorium; and that the excito-motor actions cannot take place where there is no connected nervous system; so that in the sponges and other connecting links between the animal and vegetable kingdoms, whose food is constantly in their immediate proximity, the supply of the absorbent system is effected wholly by the direct stimulus applied to the tissues themselves.

Now a consideration of these facts (which might be similarly traced with regard to the respiratory and generative systems) will lead us to see why the impression should, in the higher organisms, be followed by sensation; and why, in the highest sensation, should give rise to mental acts terminating in volition. Each train of actions requires for its maintenance the stimulus of food, and this has to be supplied by the train above. Thus a cistern-full of water may be speedily emptied by a cock occasionally opened at the bottom, but may be kept full by a ball-cock floating on the surface, and communicating with a reservoir. Now here the action of the ball-cock at the top is not essential to the flow of water at the bottom, but is consecutive to it; it is, however, essential to the continuance of the latter by the supply which it thus insures. Just such is the case with regard to the food of animals. The acephalous infant would not be able to maintain its own existence, because incapable of per-

forming those higher processes which are essential to the maintenance of those which it can execute; and yet these last are fully adequate, as long as its food is supplied from extrinsic resources, just as they are sufficient for the support of those simpler beings whose food is constantly within their reach.

If we turn our attention to the other extremity of the alimentary tube, we may observe a similar necessity for the sequence of sensations upon impressions. In the lowest animals, as in plants, the discharge of excrementitious matter is an act as completely involuntary as the introduction of aliment into the system. Thus in the sponges, the currents of water issuing from the fæcal orifices are observed to continue without intermission during the life of the animal. In proportion as we ascend in the scale, however, we observe special reservoirs adapted for the temporary retention of the excrements; and a particular set of associated muscular movements required for emptying them. If we believe, as I think that we have a right to do, that part of these movements at least are, like those of respiration, the result of impressions only, we have no difficulty in understanding why sensations are associated with them in the perfect organism. These sensations give rise to volition, by the action of which the otherwise involuntary movements are controlled and regulated; and we have constant opportunities of witnessing the result of deficiency in this controlling power.

A similar illustration of the necessary connection of sensation with impressions in ministering to the support of the organic functions might be drawn from the function of respiration. According to the view already stated, the muscular movements required for its performance are simply the result of an *impression* producing direct stimulation through the nervous circle. But we will suppose that during sleep or slight intoxication, a person falls into a position in which the respiration is obstructed by stoppage of the mouth and nostrils, or pressure on the trachea; the *sensation* then produced will call into play other muscular movements, probably to be regarded as instinctive, for the purpose of getting rid of the obstruction. But if the sleep be too profound, as that resulting from narcotics, or severe intoxication, the individual will perish because no *sensation* is produced on the brain, although the respiratory movements would have been continued if not interrupted by external causes. Many a drunkard has been drowned by the accidental immersion of his face in a street puddle.

If the views above stated be correct, the office of the nervous system in its simplest form is merely to convey an impression from one part of the animal organism to another; and next, to refer all these to the *sensorium commune*, where they may be har-

monised and more or less controlled by mental influence. Now, the number and variety of the *organic instincts* going on in the system, and which are common to it with the vegetable kingdom, require to be placed in more direct and immediate relation with one another than could be effected by the circulating system, which is their only mode of communication in plants. This is accomplished by means of the sympathetic system of nerves, which also has for its office to convey to the processes of organic life the influence of mental emotions. All the sympathies manifested in these functions are, I think, to be referred to this class of nerves, whilst those of the organs of animal life are, as I have endeavoured to prove, performed by the spinal chord and its nerves.

Another important inference presents itself with regard to the localization of instincts. If the views above stated be correct, the instinct originates in the organ which is the subject of the impression, whether internal or external; and from this impression or the sensations which follow, certain motions result. These may be accompanied with various mental changes, which are not, however, essential, further than that they may give rise to intellectual operations and voluntary motions as the consequence of them, which have the gratification of the instinctive desire as their remote object.

In proportion as we rise in the scale of animal existence, we perceive an increase in the purely mental powers, manifested in the obscuration (not the total suppression) of the instinctive tendencies, and the consequent variation between the actions of two individuals of the same species placed in similar circumstances. This increase appears to me to bear a constant relation with that of the hemispheric ganglia, or the part of the nervous system corresponding to them; but it seems obvious that we are not to look in these masses for the seat of those bodily instincts which belong, not to the *sensorium commune*, but to the whole organism.

It is easy to perceive the final cause of the fact already noticed, that the actions which in the lower animals and in the infant are instinctive, and therefore involuntary, are in the adult human being the result of reasoning processes called into action by sensation and perception, and terminating in an act of volition. If the organization of the human system had been adapted to perform all the actions necessary for the continued maintenance of its existence with the same certainty and freedom from voluntary effort as we perceive where pure instinct is the governing principle, and if all his sensations had given rise to instinctive perceptions, instead of those perceptions being acquired by the exercise of the mind, it is evident that external

circumstances could have created no stimulus to the improvement of his intellectual powers, and that the strength of his instinctive propensities would have diminished the freedom of his moral agency.

In whatever point of view we regard the physical, mental, or moral constitution of man, we cannot but be struck with the degree in which he is left to his own resources. He alone is obliged to protect himself by clothing from the inclement elements;—he alone is furnished with the ingenuity necessary to provide it. It is a part of the instinctive or innate constitution of the bee or ant to lay up stores of food for the period of dearth; in man it is left to his own prudence and foresight, and though to all the actions *immediately* necessary for the maintenance of his own existence and the continuance of his race, a powerful instinct strongly impels him, these propensities could not be gratified if the means were not provided by the exercise of the mental powers which he enjoys in a degree far exceeding those of any other terrestrial being.

In tracing the progressive complication of the psychical manifestations of the human being during early childhood, I think that a remarkable correspondence may be observed with the gradual increase in mental endowments which is to be remarked in ascending the animal scale; and that a careful analysis of these changes would thus establish in regard to them the beautiful law which has been shown to govern the development of the corporeal structure. I must leave it to abler metaphysicians than myself to work out the details of this application, confining myself at present to such a sketch as may illustrate my meaning. The first actions of an infant are evidently of a purely instinctive character; they are directed solely to the supply of its physical wants; and if the previous argument be correct, they may result from impressions, without the necessary intervention of sensations, though, if the nervous system be perfect, the latter must follow. This is evidently an analogous state to that which exists in the lowest animals possessed of a nervous system and entirely governed by instinct. The new sensations which are constantly being excited by surrounding objects, call into play the dormant powers of mind; perceptions are formed, and notions thus acquired of the character and position of external things; and the simple process of association and its concomitant, memory, are actively engaged during the first months of an infant's life. At the same time an attachment to persons and places begins to manifest itself. All these are the characteristics of the great majority of the lower Vertebrata, as far at least as our knowledge of their springs of action enables us to form a judgment. As the infant advances in age, the powers of observation are strengthened; the perceptions become more

complete ; and those powers of reflection are added which prompt him to reason upon the causes of what he observes, and to perform actions resulting from more complicated mental processes than those which guide the infant ; at the same time we observe the development of the moral feelings, but these are manifested only towards beings who are the objects of sense. I think that we may discover among the more sagacious quadrupeds, instances of reasoning as close and prolonged as that which usually takes place in early childhood ; and the attachment of the dog to man is evidently influenced by moral feelings of which he is the object. Up to this point, then, we observe nothing peculiar in the character of man ; and it is only when his higher intellectual and moral endowments begin to manifest themselves, especially those relating to an invisible being, that we can point to any obvious distinction between the immortal Ψυχη of man, and the transitory Πνευμα of the brutes that perish.

General Summary.

The following positions may be regarded as advanced in the preceding pages. No attempt has been made to prove several of them ; since, the ground having already been so frequently discussed, every one has the means of forming his judgment upon them.

1. Many living tissues possess the property of contractility upon the application of a stimulus.

2. This contractility is especially manifested by the irritable parts of certain vegetables ; and results in all these cases from the action of a stimulus either *directly* applied or conveyed through the circulating system.

3. This contractility is also especially manifested by the muscular fibre of animals, and may in them be called into play not only by the stimuli which act upon plants, but by another of a peculiar nature, commonly denominated nervous influence.

4. Whatever actions (whether consisting of visible motions or not) are performed by the tissues of plants, may be regarded as the direct respondence of their organism to external stimuli, and as solely connected with their organic life.

5. All the actions (whether consisting of visible motions or not) essential to the organic life of animals, are in like manner produced by the *immediate* action of external stimuli ;* and being entirely involuntary, may be called *organic instincts*. Under this head are included (besides many less apparent changes,) the motions of the heart and alimentary canal.

* The term *external* is here employed in the usual metaphysical sense, implying something distinct from *mental* action. The stimulus may originate in the corporeal organism itself.

6. The first office of the nervous system is to convey to a distant part the *impressions* made upon it, and to produce (by its *stimulation* of the contractile tissues) motions necessarily connected with them. These actions, being purely instinctive and involuntary, may be called *excito-motor instincts.*

7. All that is required for these manifestations is the completeness of the circle of concentric and excentric nerves. In vertebrated animals, the cerebro-spinal axis and nerves proceeding from it are of course solely concerned in this function.

8. In the lowest animals possessing a simple nervous system, these actions make up the greatest part of the sum of the life of the individual; and in the higher, they are immediately connected with the supply of the organic instincts.

9. Where a more complicated nervous system exists, the impressions give rise to mental changes termed *sensations,* the seat of which is some part of the cerebral mass in the Vertebrata, and probably the ganglia connected with the nerves of sense in the Invertebrata. With various sensations, certain involuntary motions are instinctively associated; but as *sensation*, a mental change in the sensorium, cannot immediately give rise to *stimulation*, an organic change at the extremities of the nerves, a *motive action* must be propagated from the sensorium along the nervous conductors, and this cannot result from an external impression wherever sensation does not exist. The instinctive actions thus resulting are still purely involuntary, although they may be controlled in man by the higher power of the will. Certain habitual actions may come to take place nearly in the same circle, which may be called that of *sensori-motor instincts.*

10. Voluntary actions require *perceptions* in addition to sensations and impressions. Perceptions give rise to mental processes terminating in *volition*, which produces motive action and stimulation. Volition is of course confined to the brain, and probably to the cerebral lobes.

11. No distinct division of the spinal marrow is necessary for the performance of the excito-motor, or sensori-motor instinctive actions. The same nervous matter may act as a conductor either to the influence of the will (motive action) or to that of a simple impression (stimulation.)

12. As all the nerves of sensation terminate ultimately in the cerebro-spinal axis, (the spinal cord and its prolongations as far as the *crura cerebri* and *corpora quadrigemina*) and all the nerves of motion arise from it, it follows that all motions must be the result of some stimulus applied to this system; and this stimulus may either be given by an impression from without, or by a mental change within (or in the brain above.) If we regard the cincritious matter of the brain as a seat of conscious-

ness, sensation, the intellectual powers, and volition, the medullary portion of the hemispheric ganglia being merely a conductor, (a position which I do not wish to be understood as advocating,) it necessarily follows, from the positions previously taken, that the sensory and motor tracts in the brain simply convey *upwards* to the cineritious matter, the influence of the impressions existing in the cerebro-spinal axis, and *downwards* the motive action resulting either immediately from sensation, or from volition.

EDINBURGH:
PRINTED BY JOHN STARK, OLD ASSEMBLY CLOSE.